ICE™-5100/044 In-Circuit Emulator for the RUPI™-44 Family

- **Precise, Full-Speed, Real-Time Emulation of the RUPI™-44 Family of Peripherals**
- **64 KB of Mappable High-Speed Emulation Memory**
- **254 24-bit Frames of Trace Memory (16 Bits Trace Program Execution Addresses and 8 Bits Trace Eternal Events)**
- **Serial Link to Intel Series III/IV or IBM* PC AT or PC XT (and PC DOS Compatibles)**
- **ASM-51 and PL/M-51 Language Support**
- **Built-in CRT-Oriented Text Editor**
- **Symbolic Debugging Enables Access to Memory Locations and Program Variables**
- **Four Address Breakpoints Plus In-Range, Out-of-Range, and Page Breaks**
- **Equipped with the Integrated Command Directory (ICD™) That Provides**
  - **— On-Line Help**
  - **— Syntax Guidance and Checking**
  - **— Command Recall**
- **On-Line Disassembler and Single-Line Assembler to Help with Code Patching**
- **Provides an Ideal Environment for Debugging BITBUS™ Applications Code**

The ICE™-5100/044 in-circuit emulator is a high-level, interactive debugger that is used to develop and test the hardware and software of a target system based on the RUPI™-44 family of peripherals. The ICE-5100/044 emulator can be serially linked to an Intellec® Series III/IV or an IBM PC AT or PC XT. The emulator can communicate with the host system at standard baud rates up to 19.2K. The design of the emulator supports all of the RUPI-44 components at speeds up to and including 12 MHz.

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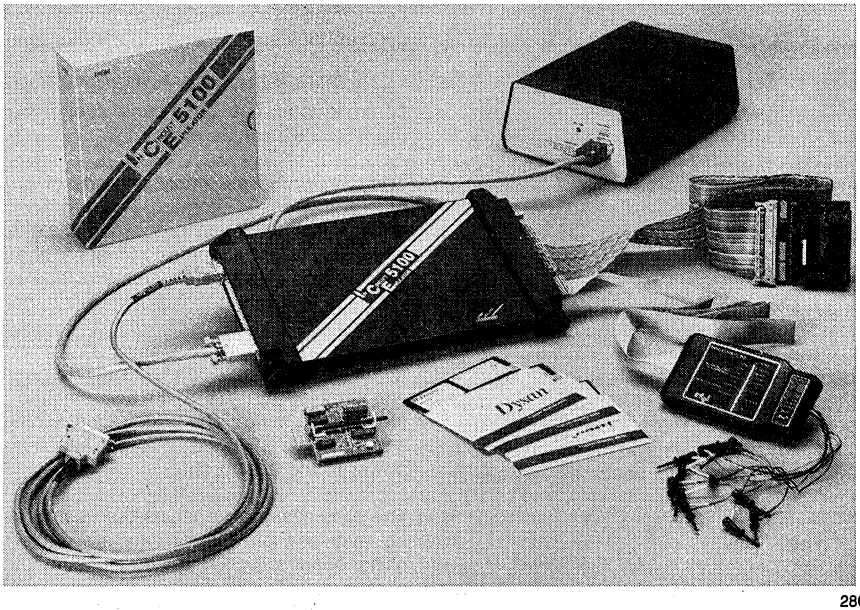

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PRODUCT OVERVIEW

The ICE-5100/044 emulator provides full emulation support for the RUPI-44 family of peripherals, including 8044-based BITBUS™ board products. The RUPI-44 family consists of the 8044, the 8744, and the 8344.

The ICE-5100/044 emulator enables hardware and software development to proceed simultaneously. With the ICE-5100/044, prototype hardware can be added to the system as it is designed and software can be developed prior to the completion of the hardware prototype. Software and hardware integration can occur while the product is being developed.

The ICE-5100/044 emulator assists four stages of development:

- Software debugging
- Hardware debugging
- System integration
- System test

Software Debugging

The ICE-5100/044 emulator can be operated without being connected to the target system and before any of the user's hardware is available (provided external data RAM is not needed). In this stand-alone mode, the ICE-5100/044 emulator can be used to facilitate program development.

Hardware Debugging

The ICE-5100/044 emulator's AC/DC parametric characteristics match the microcontroller's. The emulator's full-speed operation makes it a valuable tool for debugging hardware, including time-critical serial port, timer, and external interrupt interfaces.

System Integration

Integration of software and hardware can begin when the emulator is plugged into the microcontroller socket of the prototype system hardware. Hardware can be added, modified, and tested immediately. As each section of the user's hardware is completed, it can be added to the prototype. Thus, the hardware and software can be system tested in real-time operation as each section becomes available.

System Test

When the prototype is complete, it is tested with the final version of the system software. The ICE-5100/044 emulator is then used for real-time emulation of the microcontroller to debug the system as a completed unit.

The final product verfication test can be performed using the ROM or EPROM version of the microcontroller. Thus, the ICE-5100/044 emulator provides the ability to debug a prototype or production system at any stage in its development without introducing extraneous hardware or software test tools.

PHYSICAL DESCRIPTION

The ICE-5100/044 emulator consists of the following components (see Figure 1):

- Power supply
- AC and DC power cables
- Controller pod
- Serial Cable (host-specific)
- User probe assembly (consisting of the processor module and the user cable)
- Crystal power accessory (CPA)
- 40-pin target adaptor
- Clips assembly
- Software (includes the ICE-5100/044 emulator software, diagnostic software, and a tutorial)

The controller pod contains 64 KB of emulation memory, 254- by 24-bit frames of trace memory, and the control processor. In addition, the controller pod houses a BNC connector that can be used to connect up to 10 multi-ICE compatible emulators for synchronous starting and stopping of emulation.

The serial cable connects the host system to the controller pod. The serial cable supports a subset of the RS-232C signals.

The user probe assembly consists of a user cable and a processor module. The processor module houses the emulation processor and the interface logic. The target adaptor connects to the processor module and provides an electrical and mechanical interface to the target microcontroller socket.

The crystal power accessory (CPA) is a small, detachable board that connects to the controller pod and enables the ICE-5100/044 emulator to run in stand-alone mode. The target adaptor plugs into the socket on the CPA; the CPA then supplies clock and power to the user probe.

The clips assembly enables the user to trace external events. Eight bits of data are gathered on the rising edge of $\overline{\text{PSEN}}$ during opcode fetches. The clips information can be displayed using the CLIPS option with the PRINT command.

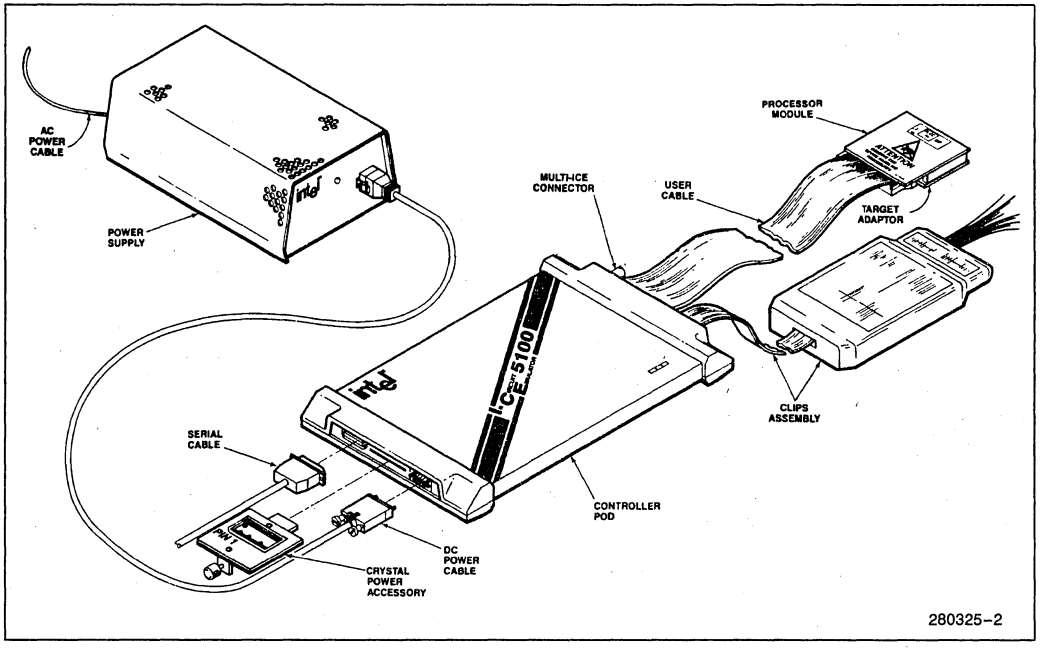

Figure 1. The ICE™-5100/044 Emulator Hardware

The ICE-5100-044 emulator software supports mnemonics, object file formats, and symbolic references generated by Intel's ASM-51 and PL/M-51 programming languages. Along with the ICE-5100/044 emulator software is a customer confidence test disk with diagnostic routines that check the operation of the hardware.

The on-line tutorial is written in the ICE-5100 command language. Thus, the user is able to interact with and use the ICE-5100/044 emulator while executing the tutorial.

A comprehensive set of documentation is provided with the ICE-5100/044 emulator.

ICE™-5100/044 EMULATOR FEATURES

The ICE-5100/044 emulator has been created to assist a product designer in developing, debugging and testing designs incorporating the RUPI-44 family of peripherals. The following sections detail some of the ICE-5100/044 emulator features.

Emulation

Emulation is the controlled execution of the user's software in the target hardware or in an artificial hardware environment that duplicates the microcontroller of the target system. Emulation is a transparent process that happens in real-time. The execution of the user software is facilitated with the ICE-5100/044 command language.

Memory Mapping

There is a 64 KB of memory that can be mapped to the CODE memory space in 4 KB blocks on 4 KB boundaries. By mapping memory to the ICE-5100/044 emulator, software development can proceed before the user hardware is available.

Memory Examination and Modification

The memory space for the 8044 microcontroller and its target hardware is fully accessible through the emulator. The ICE-5100/044 emulator refers to four physically distinct memory spaces, as follows:

- CODE—references program memory
- IDATA—references internal data memory
- RDATA—references special function register memory
- XDATA—references external data memory

ICE-5100/044 emulator commands that access memory use one of the special prefixes (e.g., CODE) to specify the memory space.

The microcontroller's special function registers and register bits can be accessed mnemonically (e.g., DPL, TCON, CY, P1.2) with the ICE-5100/044 emulator software.

Data can be displayed or modified in one of three bases: hexadecimal, decimal, or binary. Data can also be displayed or modified in one of two formats: ASCII or unsigned integer. Program code can be disassembled and displayed as ASM-51 assembler mnemonics. Code can be modified with standard ASM-51 statements using the built-in single-line assembler.

Symbolic references can be used to specify memory locations. A symbolic reference is a procedure name, line number, program variable, or label in the user program that corresponds to a location.

Some typical symbolic functions include:

- Changing or inspecting the value of a program variable by using its symbolic name to access the memory location.
- Defining break and trace events using symbolic references.
- Referencing variables as primitive data types. The primitive data types are ADDRESS, BIT, BOOLEAN, BYTE, CHAR (character), and WORD.

The ICE-5100/044 emulator maintains a virtual symbol table (VST) for program symbols. A maximum of 61 KB of host memory space is available for the VST. If the VST is larger than 61 KB, the excess is stored on available host system disk space and is paged in and out as needed. The size of the VST is limited only by the disk capacity of the host system.

Breakpoint Specifications

Breakpoints are used to halt a user program in order to examine the effect of the program's execution on the target system. The ICE-5100/044 emulator supports three different types of break specifications:

- Specific address break—specifying a single address point at which emulation is to be stopped.
- Range break—an arbitrary range of addresses can be specified to halt emulation. Program execution within or, optionally, outside the range halts emulation.
- Page break—up to 256 page breaks can be specified. A page break is defined as a range of addresses that is 256-bytes long and begins on a 256-byte address boundary.

Break registers are user-defined debug definitions used to create and store breakpoint definitions. Break registers can contain multiple breakpoint definitions and can optionally call debug procedures when emulation halts.

Trace Specifications

Tracing can be triggered using specifications similar to those used for breaking. Normally, the ICE-5100/044 emulator traces program activity while the user program is executing. With a trace specification, tracing can be triggered to occur only when specific conditions are met during execution. Up to 254 24-bit frames of trace information are collected in a buffer during emulation. Sixteen of the 24 bits trace instruction execution addresses, and 8 bits capture external events (CLIPS).

```
        /* Print newest four instructions in the buffer */
hlt>PRINT NEWEST 4
FRAME    ADDR      CODE      INSTRUCTIONS
(28)     300A      C02A      PUSH    2AH
(30      300C      2532      ADD     A, 32H
(32)     300E      F52A      MOV     2AH, A
(34)     3010      B53210    CJNE    A,32H, $+10H
hlt>
hlt>PRINT CLIPS OLDEST 2     /* Buffer display showing clips */
FRAME    ADDR      CODE      INSTRUCTIONS   CLIPS     (76543210)
(00)     007AH     0508      INC  INDX PTR             10101111
(01)     007CH     80E6      SJMP (#28)                00100010
```

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Figure 2. Selected Trace Buffer Displays

The trace buffer display is similar to an ASM-51 program listing as shown in Figure 2. The PRINT command enables the user to selectively display the contents of the trace buffer. The user has the option of displaying the clips information as well as dissassembled instructions.

Procedures

Debugging procedures (PROCs) are a user-defined group of ICE-5100/044 commands that are executed as one command. PROCs enable the user to define several commands in a named block structure. The commands are executed by entering thename of the PROC. The PROC bodies are a simple DO . . . END construct.

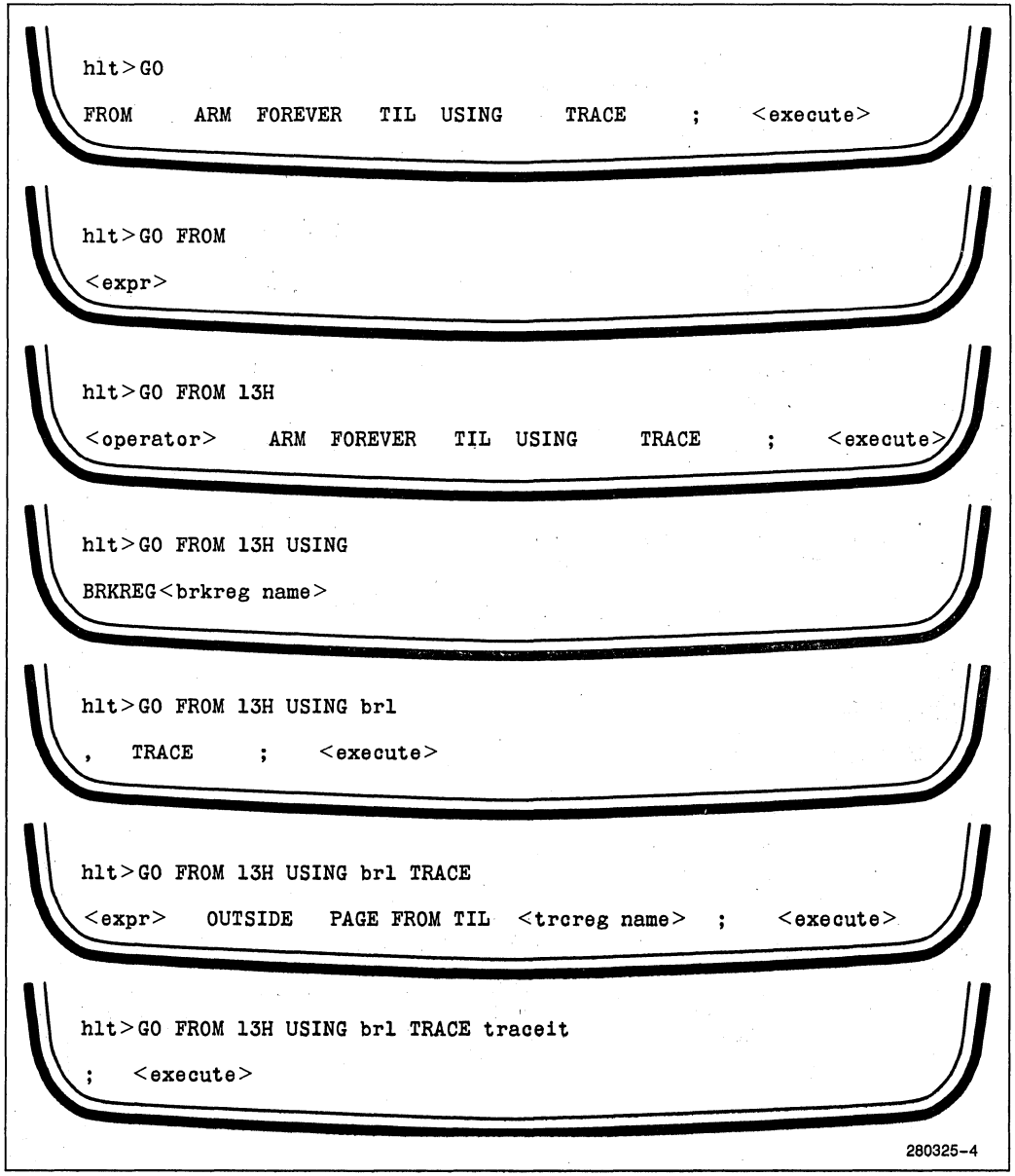

Figure 3. The Integrated Command Directory for the GO Command

PROCs can simulate missing hardware or software, set breakpoints, collect debug information, and execute high-level software patches. PROCs can be copied to text files on disk, then recalled for use in later test sessions. PROCs can also serve as program diagnostics, implementing ICE-5100/044 emulator commands or user-defined definitions for special purposes.

On-Line Syntax Menu

A special syntax menu, called the Integrated Command directory (ICD), similar to the one used for the I²ICE™ system and the VLSiCE-96 emulator, aids in creating syntactically correct command lines. Figure 3 shows an example of the ICD and how it changes to reflect the options available for the GO command.

Help

The HELP command provides ICE-5100/044 emulation command assistance via the host system terminal. On-line HELP is available for the ICE-5100/044 emulator commands shown in Figure 4.

BITBUS™ Applications Support

The ICE-5100/044 emulator provides an ideal environment for developing applications code for BITBUS board products such as the RCB-44/10, the RCB-44/20, the PCX-344, and the iSBX™-344 board.

The BITBUS firmware, available separately as BITWARE, can be loaded into the ICE-5100/044 emulator's memory along with the user's code to enable rapid debug of 8044 BITBUS applications code.

DESIGN CONSIDERATIONS

The height of the processor module and the target adaptor need to be considered for target systems. Allow at least 1½ inches (3.8 cm) of space to fit the processor module and target adaptor. Figure 5 shows the dimensions of the processor module.

Execution of user programs that contain interrupt routines causes incorrect data to be stored in the trace buffer. When an interrupt occurs, the next instruction to be executed is placed into the trace buffer before it is actually executed. Following completion of the interrupt routine, the instruction is executed and again placed into the trace buffer.

ELECTRICAL CONSIDERATIONS

The emulation processor's user-pin timings and loadings are identical to the 8044 component, except as follows.

- Up to 25 pF of additional pin capacitance is contributed by the processor module and target adaptor assemblies.
- Pin 31, $\overline{EA}$, has approximately 32 pF of additional capacitance loading due to sensing circuitry.
- Pins 18 and 19, XTAL1 and XTAL2 respectively, have approximately 15-16 pF of additional capacitance when configured for crystal operation.

```
hlt>HELP

HELP is available for:

ADDRESS    APPEND   ASM        BASE       BIT        BOOLEAN     BRKREG
BYTE       CHAR     CI         CNTL_C     COMMENTS   CONSTRUCTS  COUNT
CURHOME    CURX     CURY       DCI        DEBUG      DEFINE      DIR
DISPLAY    DO       DYNASCOPE  EDIT       ERROR      EVAL        EXIT
EXPRESSION GO       HELP       IF         INCLUDE    INVOCATION  ISTEP
KEYS       LABEL    LINES      LIST       LITERALLY  LOAD        LSTEP
MAP        MENU     MODIFY     MODULE     MSPACE     MTYPE       NAMESCOPE
OPERATOR   PAGING   PARTITION  PRINT      PROC       PSEUDO_VAR  PUT
REFERENCE  REGS     REMOVE     REPEAT     RESET      RETURN      SAVE
STRING     SYMBOLIC SYNCSTART  TEMPCHECK  TRCREG     TYPES       VARIABLE
VERIFY     VERSION  WAIT       WORD       WRITE
hlt>
```

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Figure 4. HELP Menu

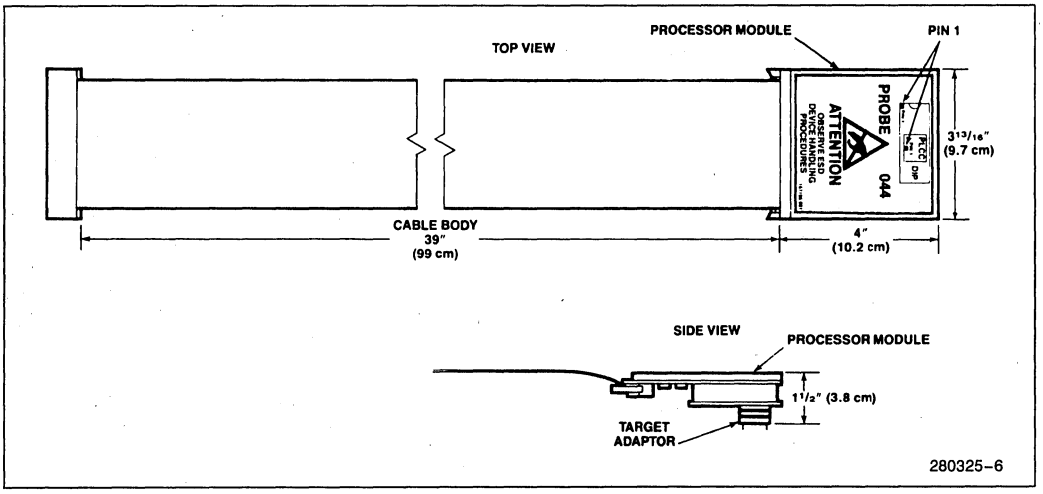

Figure 5. Processor Module Dimensions

HOST REQUIREMENTS

- IBM PC AT or PC XT (or PC DOS compatible) with 512 KB of available RAM and a hard disk running under the DOS 3.0 (or later) operating system.
- Intellec Series III/IV microcomputer development system running the ISIS or iNDX operating system respectively, with at least 512 KB of application memory resident.
- Disk drives—dual floppy or one hard disk and one floppy drive required.

ICE™-5100/044 EMULATOR SOFTWARE PACKAGE

- ICE-5100/044 emulator software
- ICE-5100/044 confidence tests
- ICE-5100 tutorial software

EMULATOR PERFORMANCE

Memory

Mappable full-speed emulation code memory	64 KB	Mappable to user or ICE-5100/044 emulator memory in 4 KB blocks on 4 KB boundaries.
Trace memory		254 x 24 bit frames
Virtual Symbol Table		A maximum of 61 KB of host memory space is available for the virtual symbol table (VST). The rest of the VST resides on disk and is paged in and out as needed.

PHYSICAL CHARACTERISTICS

Controller Pod

Width:	8-1/4"	(21 cm)
Height:	1-1/2"	(3.8 cm)
Depth:	13-1/2"	(34.3 cm)
Weight:	4 lbs	(1.85 kg)

User Cable

The user cable is 3 feet (approximately 1 m)

Processor Module

(With the target adaptor attached)

Width:	3-13/16"	(9.7 cm)
Height:	4"	(10.2 cm)
Depth:	1-1/2"	(3.8 cm)

Power Supply

Width:	7-5/8"	(18.1 cm)
Height:	4"	(10.06 cm)
Depth:	11"	(27.97 cm)
Weight	15 lbs	(6.1 kg)

Serial Cable

The serial cable is 12 feet (3.6 m).

ELECTRICAL CHARACTERISTICS

Power Supply

100-120V or 200-240V (selectable)
50-60 Hz
2 amps (AC max) @ 120V
1 amp (AC max) @ 240V

ENVIRONMENTAL CHARACTERISTICS

Operating temperature	+10°C to +40°C (50°F to 104°F)
Operating humidity	Maximum of 85% relative humidity, non-condensing

ORDERING INFORMATION

Emulator Hardware and Software

Order Code	Description
I044KITAD	This kit contains the ICE-5100/044 user probe assembly, power supply and cables, serial cables, target adaptor, CPA, ICE-5100 controller pod, software, and documentation for use with an IBM PC AT or PC XT. The kit also includes the 8051 Software Development Package and the AEDIT text editor for use on DOS systems. [Requires software license.]
I044KITD	This kit is the same as the I044KITAD excluding the 8051 Software Development Package and the AEDIT text editor. [Requires software license.]
I044KITAS	This kit contains the ICE-5100/044 user probe assembly, power supply and cables, serial cables, target adaptor, CPA, ICE-5100 controller pod, software, and documentation for use with Intel hosts (Series III/IV). The kit also includes the 8051 Software Development Package and the AEDIT text editor for use on the Series III/IV. [Requires software license.]
I044KITS	This kit is the same as the I044KITAS excluding the 8051 Software Development Package and the AEDIT text editor. [Requires software license.]

Software Only

Order Code	Description
SA044D	This kit contains the host, probe, diagnostic, and tutorial software on 5¼" disks for use on an IBM PC AT or PC XT (requires DOS 3.0 or later). [Requires software license.]
SA044S	This kit contains the host, probe, diagnostic, and tutorial software on 8" disks (both single-density and double-density) for use on a Series III, and on 5-¼" disks for use on a Series IV. [Requires software license.]

Other Useful Intel® MCS®-51 Debug and Development Support Products

Order Code	Description
D86ASM51	**8051 Software Development Package** (DOS version)—Consists of the ASM-51 macro assembler which gives symbolic access to 8051 hardware features; the RL51 linker and relocator program that links modules generated by ASM-51; CONV51 which enables software written for the MCS-48 family to be up-graded to run on the 8051, and the LIB51 Librarian which programmers can use to create and maintain libraries of software object modules. Use with the DOS operating system (version 3.0 or later).
D86PLM51	**PL/M-51 Software Package** (DOS version)—Consists of the PL/M-51 compiler which provides high-level programming language support; the LIB51 utility that creates and maintains libraries of software object modules, and the RL51 linker and relocator program that links modules generated by ASM-51 and PL/M-51 and locates the linked object modules to absolute memory locations. Use with the DOS operating system (version 3.0 or later).
I86ASM51	**8051 Software Development Package** (ISIS version)—Same as the D86ASM51 package except this one is for use with the Series III.
I86PLM51	**PL/M-51 Sofware Package**—Same as the D86PLM51 package except this one is for use with the Series III and Series IV.
D86EDINL	AEDIT text editor for use with the DOS operating system.